THE SALIENCE OF EXCISE VS. SALES TAXES ON HEALTHY EATING:

AN EXPERIMENTAL STUDY

A Thesis

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of Cornell University

In Partial Fulfillment of the Requirements for the Degree of

Master of Science

by

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ABSTRACT

Based on a laboratory experiment conducted with 131 adult non-students subjects, we empirically examine the salience of excise and sales tax on changing consumers' eating behavior. We compare the caloric and nutrient content of the meals selected by the subjects using a difference-in-difference regression model to determine the efficacy of the policy treatments. The results indicate that an inclusive tax (i.e., an excise tax) has a significantly stronger effect on reducing caloric intake compared to an exclusive tax (i.e., a sales tax), and an unhealthy food tax is in general more effective than an sugar-sweetened beverage tax in reducing intake of nutrients that contributes to obesity.

Keywords: Obesity, Tax salience, Excise tax, Sales tax

BIOGRAPHICAL SKETCH

Xiu Chen earned her Bachelor of Economics degree in Renmin University of China in 2012. In 2012, she joined the M.S program in Applied Economics and Management at Cornell University. In May 2014, she will graduate with a Master of Science degree, with a focus on agricultural economics.

During the past two years, Xiu obtained rigorous and comprehensive education in a broad array of courses in economics major, through which she has prepared herself with a strong academic background. She excelled in PhD level economic and mathematical courses, which helped her acquire the admission of the Ph.D program in Economics at Hong Kong University of Science and Technology with full studentship.

While pursuing her degree, Xiu had worked as a grader for the course of Price Analysis in the department of Applied Economics and Management for a semester. In addition, she not only participated in as an assistant, but also conducted an economic experiment as an instructor in the Lab of Experimental Economics and Decision Research (LEEDR) at Cornell University. In the short term, she looks forward to beginning her study as a Ph.D candidate in Economics at HKUST with a focus on behavioral and experimental economics.

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I. Introduction

Obesity among U.S. adults has reached epidemic proportions. As reported in 2013, the adult obesity rate in the United States is 34.9% (National Center for Health Statistics [NCHS], 2013). The prevalence of obesity among middle-aged adults was 39.5% in the United States in 2011-2012 (Ogden et al. 2013). According to the World Health Organization [WHO], obesity is a major risk factor for a number of chronic diseases, including heart disease, stroke, type II diabetes and certain types of cancer. One study estimates that the current direct and indirect costs of obesity are more than $190 billion annually in the United States (Institute of Medicine [IOM], 2013). The WHO (2013) states that the fundamental cause of people being overweight or obese is an energy imbalance between calories consumed and expended, and an increased intake of foods that are high in fat is undoubtedly one of the major contributions.

In order to reduce obesity, economic incentives/disincentives have been implemented to promote healthy diets. Chief among these policies is a tax on unhealthy foods. The Rudd Center for Food Policy and Obesity at Yale (2013) suggest two methods for raising prices of unhealthy foods: 1) tax foods with poor nutrients profiles; and 2) tax broader categories of unhealthy food and beverages, such as carbonated drinks and snacks. Most of the states and cities in the United States implementing tax policies to fight obesity have adopted the first method and levied taxes on the soft drink category. For example, San Francisco supervisors have introduced a 2-cents-per-ounce tax on sugary drinks sold in the city. More recently, the second method of levying unhealthy food tax (also known as "fat tax") is also being discussed, proposed, and even implemented in several countries. In 2011, Denmark imposed the world's first fat tax on foods with more than 2.3% saturated fats; but the policy was abolished in 2012. These food taxes are collected in the form of a higher sales tax rate compared to the regular food tax rate, or an additional excise tax. Among the thirty-three states in the United States that levy taxes on soft drinks, twenty-five of them apply only sales tax to the category, one applies only excise tax, and seven apply both excise and sales taxes (Zheng et al. 2012).

The difference between a sales and an excise tax is key to understanding how they induce different consumer behaviors. The fundamental difference is whether the tax is levied at the point of production or the point of sale. Sales taxes are typically expressed in tax-exclusive terms (Tax Policy Center, 2008), because a sales tax is not reflected by the posted-price, but rather is added at the register upon checkout. Conversely, the amount of an excise tax is included in the posted price, so an excise tax typically has higher "salience" than a sales tax. The economic literature has investigated and compared the efficacy of these two types of taxes. Miao, Beghin and Jensen (2010) suggest that both a consumption tax on sweet goods and a sweetener input tax can reduce added sweetener consumption, but the letter policy causes about five times less surplus than the former. For example, Chetty, Looney and Kroft (2009) find that consumers tend to under-react to taxes that are not included in posted prices because of the difficulty in computing the gross after-tax price. Relatedly, Zheng, McLaughlin and Kaiser (2013, henceforth ZMK) focus on the effect of imperfect tax knowledge, and conclude that a sales tax change does not reduce demand as much as an excise tax change of the same magnitude. While these and other studies are useful in understanding tax saliency, there is an absence of empirical research on the impact of applying the taxes on food and beverage demand.

Accordingly, the goal of this research is to empirically study the effect of tax salience on consumer demand for food and beverages and examine the theoretical results drawn by ZMK. As defined by Chetty, Looney and Kroft (2009), the "salience" of a tax indicates the simplicity of calculating the gross-of-tax price of a good. To achieve our goal, we designed a controlled laboratory experiment conducted with 131 adult, non-student subjects that were asked to select lunch items from a cafeteria menu. Each subjects was randomly assigned to a control group or one of the two treatments: (1) 20% excise tax on unhealthy foods and beverages and (2) 20% sales tax on unhealthy foods and beverages. We examine taxes that are levied on unhealthy foods. A difference-in-difference regression model is used to determine the efficacy of the various policy treatments in terms of reducing calories, fat, added sugar, cholesterol, and sodium intake. The result confirm our hypothesis that while both taxes reduce caloric and other nutrient intake, an inclusive tax (i.e., the excise tax) has a more significant impact on consumers' eating behavior, caloric intake and nutrient intake than an exclusive tax (i.e., a sales tax).

The remainder of the paper is organized as follows. Section 2 summarizes the related literature. Section 3 presents the theoretical framework developed from ZMK. Section 4 presents the experimental design. Section 5 presents the data and the difference-in-difference model, and discusses the estimation results. Section 6 concludes.

II. An Overview on the Debate over Fat Taxes

The idea of levying an "overweight fee" dates back to 1940s (Engber, 2009), but was not well known until the 1980s when Brownell (1980) proposed that revenue from junk-food taxes be used to subsidize more healthful foods and fund nutrition campaigns. In 1994, Brownell argued that healthy foods cost more than unhealthy foods in a New York Times, Op-Ed piece and proposed the concept of a "fat tax". Since then, the idea of adopting food tax policies to combat obesity has been discussed worldwide. Kim and Kawachi (2006) and Powell et al. (2009) find that changes in the relative prices of healthy and unhealthy foods impact consumption patterns and lower obesity levels. Brownell and Frieden (2009) argue that taxes on fattening foods have three justifications: (1) the contribution of unhealthful diets to the illnesses cited previously creates an externality to health care costs; (2) food nutritional information is asymmetric between consumers and food firms; and (3) the revenue generated from such taxes can increase societal benefits by promoting healthy diets. The authors believe that a tax on sweetened beverages would encourage consumers to switch to more healthful beverages and hence reduce caloric intake. Along the similar lines, Chaloupka et al (2011a) believe that a sizeble sugar-sweetened beverage tax will not only lead to significant reduction in calorie intake, but also generate significant new revenues that can be used to support obesity prevention effort. Chaloupka et al (2011b) furthermore argue that it would enhance the effectiveness of large sugar sweetened beverage tax if the revenue generated were dedicated to obesity prevention efforts.

However, these results are not universally accepted in the literature, notably among economists that believe existing evidence on the effectiveness of fat taxes is mixed. Cash et al. (2007) suggest that the economic evidence on food price interventions to improve healthy diets is far from complete; therefore the impact of such policies is unclear. Chouinard et al. (2007) argue that fat taxes are extremely regressive, and would cause greater welfare losses on the elderly and poor. Similarly, Engber (2009) contends that a fat tax would fall disproportionately on poorer people who tend to consume more fattening food and who are more sensitive to price. Gandel (2011) casts doubt on the efficacy of taxing unhealthy food, suggesting that taxes have little impact on altering consumer behavior. Fletcher et al (2011a) argue that policymakers can improve sugar-sweetened beverage tax by expanding its scope and motivation. They suggest that expanding the scope of a tax to include all calorie-dense foods besides sugar-sweetened beverages would enhance the effectiveness of such policy, and motivating it as a way to improve population health instead of just reducing obesity would lead to a more desirable outcome. Fletcher et al (2011b) believe that to achieve a broader goal of improving population health requires a more comprehensive policy that includes not only the sugar sweetened beverage tax, but also other restrictions. An empirical study by Lusk and Schroeter (2013) suggests that a soda tax is very unlikely to be welfare enhancing, unless it is justified on the grounds that abandon standard rationality assumptions.

Among the supporters of fat tax policies, the question of which stage, production or sale, should the tax be levied at has attracted much attention. Engelhard et al. (2009) argue that although an “upstream” tax can avoid administrative complications for stores, a sales tax has countervailing advantages, including generating revenue that rises with inflation, and allowing for a short-term tax exemption. Brownell and Frieden (2009), however, point out that by levying tax as a percentage of the retail price, sales tax policies would actually encourage the purchase of larger containers at a lower unit price; while an excise tax structured as a fixed cost per ounce would be more effective in reducing consumption. The authors also indicate that as manufacturers pass the excise tax along to customers, the amount of the tax would be included in the price consumers see when making selection, and therefore cause a greater drop in consumption than a sales tax.

In order to examine how an exclusive tax such as a sales tax would lead to sub-optimizing shopping behavior, Chetty, Looney and Kroft (2009) conduct a field experiment and an observational study, according to which they conclude that salience is an important determinant of the effect of a tax. To explain their empirical findings, they introduce small cognitive costs into the neoclassical model of consumer choice and show that small cognitive costs can significantly affect the welfare consequences of tax policies. Likewise, Feldman and Ruffle (2012) test the equivalence of tax-inclusive and tax-exclusive prices, and show based on data generated from a lab experiment that people buy more under a tax-exclusive regime than under an equivalent tax-inclusive regime. But as in each round of their experiment, they either include the tax in the prices of all items, or exclude it from the prices of all items, their results does not reveal the effect of consumers' knowledge about the tax status. ZMK examines such effect. They focus on food and beverage demand, and develop a theoretical framework to investigate the effect of a change in sales or excise taxes. They assume that while consumers have good knowledge of the tax rate, they are sometimes inattentive to sales tax, and may have misperception of the tax status of some items. They find that although both the effects of a sales tax and an excise tax are influenced by imperfect tax knowledge, the effect that an excise tax change has on demand is largely comparable with that of a price change, while a sales tax fails to affect demand as much as an excise tax of the same magnitude.

While these studies provide a solid theoretical foundation and empirical evidence on the effect of tax salience on consumer demand, the research summarized here contributes to the scarce empirical literature on the impact of tax salience on healthy eating behavior. The principle purpose of this research is to conduct a luncheon experiment to provide empirical evidence for the conclusions drawn from the theoretical model of ZMK. Compared to the existing empirical studies, this research uses a controlled laboratory experiment where subjects are given adequate time to make a more careful purchasing decision than they do in a field study, thus it better reveals the actual effect of tax salience on consumer's selection. This is the first paper, to our knowledge, to examine the impact of tax salience concentrating on healthy and unhealthy food consumption using data generated from a controlled laboratory experiment. The theoretical model and the structure of the experiment are described below.

III. Theoretical Framework

The ZMK model is based on the assumption that although consumers have good knowledge of the sales tax rate, they may under-reacting a sales tax, and have misperceptions concerning the tax status (whether the product is taxable or exempt) of each item. In the model presented below, it is assumed that there are four types of consumers[1]:

A. Consumers who know the tax status on food and beverage items before and after the tax change;

B. Consumers who know the tax status before the tax change but misperceive it after the tax change;

C. Consumers who misperceive the tax status before the tax change but correct it after the tax change;

D. Consumers who misperceive the tax status before and after the tax change.

To evaluate the impact of tax on the demand for food and beverages, ZMK follow Chetty et al. (2009) and develop a log-linearized demand function. Adopting the notation in ZMK, Let $x\,(p,r)$ denote total demand for food and beverages that is subject to an unhealthy food tax, p denotes the shelf price and r the tax rate. Accordingly, the demand function before the tax change is:

$$(1)\quad ln\, x_c(p,r) = ln\,(\alpha p^{\beta}[1+V_b(r)^{\theta\beta}]\}$$

where $V\,(r)$ indicates consumers' perceived tax rate before the change in policy, θ measures the degree of consumers' underreacting to a tax, and β is the price elasticity of

[1] ZMK divides consumers into four groups by taking into consider whether consumers have correct information of the change of tax rate. As both the excise and sales tax rates are clearly stated in all the treatment groups of our experiment, we classify consumers only according to their knowledge of the tax status. To simplify our model, we do not take SNAP users into account.

the demand. The subscript c indicates the four consumer types, $c = 1,1;\ 1,0; 0,1; 0,0$ for type A, B, C, D respectively. The subscript $b = 1$ if consumers belong to type A and type B, and $b = 0$ otherwise.

Similarly, the demand function after the tax change $x'\,(p, r')$ is:

(2) $ln\, x'_c(p, r') = ln\,(\alpha p^{\beta}[1 + V'_c(r')^{E\,(\theta)\,\beta}]\}$

where r' the new tax rate after the change of the policy. $E(\theta) = 1$ if an excise tax is imposed, and $E(\theta) = \theta$ if a sales tax is imposed.

Since the total demand $x = x_{1,1} + x_{1,0} + x_{0,1} + x_{0,0}$, now the rate of change in the total demand can be derived as:

(3)

$$d\, ln\, x = \beta\, \{K_1 K'_1\, ln\, \frac{[1+V'_{1,1}(r\prime)]^{E(\theta)}}{[1+V_1(r)]^{\theta}} + K_1 K'_0\, ln\, \frac{[1+V'_{1,0}(r\prime)]^{E(\theta)}}{[1+V_1(r)]^{\theta}} + K_0 K'_1\, ln\, \frac{[1+V'_{0,1}(r\prime)]^{E(\theta)}}{[1+V_0(r)]^{\theta}} + K_0\, K'_0\, ln\, \frac{[1+V'_{0,0}(r\prime)]^{E(\theta)}}{[1+V_0(r)]^{\theta}}\}$$

where K and K' are the knowledge parameters introduced by ZMK, indicating the knowledge levels of consumers about the tax status before and after the tax change, respectively.

Before the tax policy is implemented, there is no tax on all food items. Therefore

$V_1(r) = 0$ for type A and B consumers. But for the other consumers, who may misperceive the tax status and believe that there is a tax with rate r, $V_0(r) = r$.

First, suppose that the government decides to levy an excise tax on unhealthy food and beverages. Since an excise tax is a price inclusive tax, there will be no under-reactions, and therefore $E(\theta) = 1$ as defined. And $V'_{1,1}(r') = V'_{1,0}(r') = V'_{0,1}(r') = r'$, but $[1 + V'_{0,0}(r')]^{D(\theta)} = (1 + r')^{D(\theta)}(1 + r)^{\theta}$ because for type D consumers, there is a misperceived sales tax in addition to the actual excise tax. Hence, the percentage change in the demand can be calculated by:

$$(4)\ d\ ln\ x^e = \beta\ \{ln\ (1 + r') - \theta K_0\ K'_1 ln\ (1 + r)\}$$

Now consider the case where the government levies a sales tax on unhealthy food and beverages. In this case, $V'_{1,1}(r') = V'_{0,1}(r') = r'$, but $V'_{1,0}(r') = V'_{0,0}(r') = 0$ because consumers of type B and D misperceive the tax status after the tax change. $E(\theta) = \theta$ as defined. Hence, the percentage change in the demand is:

$$(5)\ d\ ln\ x^s = \beta\ \theta\ \{K'_1\ ln\ (1 + r') - K_0\ ln\ (1 + r)\}$$

To evaluate the difference between the impacts of an excise tax and that of a sales tax, we compare equation (4) and (5) in equation (6):

$$(6)\ \ d\ ln\ x^e - d\ ln\ x^s$$

$$= \beta(1-\theta K'_1)[ln\ (1+r') + K_0\ ln\ (1+r)]$$

which is greater than 0 since $\theta < 1$ and $K'_1 < 1$. Hence, the result leads to the conclusion that a sales tax change does not reduce the demand as much as an excise tax change. This is the main hypothesis that we test with our experiment data and empirical model.

IV. Experimental Design

A total of 131 adult non-student subjects participated in the economic experiment. Subjects were paid \$20 cash, plus a \$10 voucher that could be spent exclusively on food items that they selected from the lunch menu used in the experiment[2]. The lunch menu contained food items in three main categories: entrées, beverages, and desserts. Each category consisted of relatively healthy (e.g., veggie cup) and unhealthy (e.g., cheese burger) items.

Each subject viewed three menus. The first menu presented the base prices that were the same across the control and two treatment groups. The prices on the second and the third menu varied by treatment (see the full list of food items and prices on each menu in Appendix, A1).

There were three parts in the experiment. In each part, subjects were asked to select

[2] The list of food items and prices were from the menu of "Trillium" dining hall where subjects can easily redeem the voucher and get their selected meal after the experiment.

food and beverage items from a lunch menu presented to them in the course of the experiment. They were asked to use the $10 endowment of vouchers to pay for their lunch selections. The participants were told that they would complete a series of menus and that one of the completed menus was randomly drawn before the start of the experiment, and that the choice of lunch food items on this particular menu would be binding for them. If they spent less than $10 on the drawn menu, they could not receive the excess in cash, and if they spent over $10, they could use part of their $20 cash payment in addition to the $10 endowment to pay for the selected items on the drawn menu.

In Part 1, all subjects were asked to select lunch items from menu 1. Prices on menu 1 were the same across all groups including the control and the two treatments.

In Part 2, the control group was presented with the exact same menu as menu 1, while the two treatments were provided with different menus:

Treatment I. Inclusive tax treatment. Subjects in this group were provided a menu 2 in this part, where the prices of unhealthy items were increased by a 20% excise tax, while prices of other items remained the same as on menu 1. We included a note was at the top of subjects' computer screens that read: "A 20% 'unhealthy food' excise tax has been added to the price of unhealthy food and beverages."

Treatment II. Exclusive tax treatment. Subjects in this group were provided a menu 2 in this part, where prices of all items were the same as on menu 1, but with the following note on top of the screen: "A 20% 'unhealthy food' sales tax will be added to your purchase when you check out. "

In Part 3, the control group was presented with the exact same menu as menu 1, while the two treatments were provided with different menus:

Treatment I. Inclusive tax treatment. Subjects in this group were provided a menu 3 in this part, where the prices of added sweetened beverage items were increased by a 20% excise tax, while prices of other items remained the same as on menu 1. We included a note was at the top of subjects' computer screens that read: "A 20% 'added sweetened beverage' excise tax has been added to the price of added sweetened beverages."

Treatment II. Exclusive tax treatment. Subjects in this group were provided a menu 3 in this part, where prices of all items were the same as on menu 1, but with the following note on top of the screen: "A 20% 'added sweetened beverage' sales tax will be added to your purchase when you check out. "

For subjects in the control group and in the two treatment groups, the menus were presented on the computer screen. For the control group and treatment I, the total price was presented to them at the bottom of the screen. For treatment II, the subtotal price before sales tax was presented to them at the bottom of the screen, but the after-tax price was not presented to them until they checked out, and they could not return to change their orders.

At the beginning of each part, participants were presented with written and oral instructions on how the computerized menus work. Subjects in the two tax treatments were also presented information about the taxes. During each part, participants were given enough time to complete their menus. After all parts were completed, participants were asked to complete a computerized questionnaire collecting their demographic information. The complete list of all the questions asked in the computerized survey is presented in appendix A2

V. Data and Estimation

A set of difference-in-difference regression models and an ordered probit model were used to examine the impacts of the treatment in different ways. The difference-in-difference models, which provided the major results of this paper, were estimated to determine the impact of the treatments on the intake of some major nutrients including calorie, protein, added sugar, etc. These models measured the actual effect of the treatments on nutritional content of selected lunch. The ordered probit model was used to estimate by how much the advertising treatments changed subjects' choice of unhealthy items. This model was employed to evaluate how different types of taxes impacted consumers' purchases of items that they generally perceived as unhealthy.

i) Difference-in-difference Model

The first econometric model we use to examine the impacts of the treatments on caloric intake and nutrient intake is a difference-in-difference (DID) model. As we have data on the same individuals in both pre- and post- periods, the original form of the DID model is applicable:

$$\Delta Y_i = \alpha_0 + \sum_{j=1}^{2} \beta_j D_j + \alpha_1 X_i + \varepsilon_i \quad (7)$$

where ΔY_i is the difference in content of nutrient Y from menu 1 to menu 2 (or menu 3) for individual i. We calculate ΔY_i by summing the nutrient Y of items selected by individual i on each menu, then subtracting the total value of it on menu 1 from that on menu 2 (or menu 3). The term D_j is a series of treatment dummies, and X_i is a vector of control variables indicating the socio-demographic characteristics of individual i.

In this study we choose the following nutritional factors to focus on, according to the Report of Dietary Reference Intakes (2010) and Dietary Guidelines Advisory Committee Report (Agricultural Research Service (ARS), 2010): calories, empty calories, calorie from fat, carbohydrate, fiber, fat, cholesterol, protein, added sugar and sodium. Most of the nutritional information was obtained from the National Agricultural Library of USDA (www.ndb.nal.usda.gov), and the Center for Nutrition Policy and Promotion (CNPP, https://www.supertracker.usda.gov/default.aspx), an organization of USDA. Some nutritional information on beverages was obtained from either the manufacturer's official website (http://www.pepsicobeveragefacts.com/) or the nutritional label on the package.

We employ seemingly unrelated regression (SUR) estimation, due to the statistical inefficiency of multiple equation ordinary least squares (OLS) in estimating the treatment effects on correlated content of nutrients for each individual.

Results

Table 1. Descriptive Statistics of Selected Variables by Treatment[3]

		Treatment			
		All	Control	Inclusive tax	Exclusive tax
Female		0.817 (0.388)	0.825 (0.385)	0.875 (0.334)	0.744 (0.441)
Age	**Less than 20**	0.176 (0.382)	0.1 (0.304)	0.208 (0.410)	0.209 (0.412)
	21-30	0.221 (0.417)	0.225 (0.423)	0.146 (0.357)	0.302 (0.465)
	31-40	0.344 (0.477)	0.375 (0.490)	0.333 (0.476)	0.326 (0.474)
	41-50	0.252 (0.436)	0.3 (0.464)	0.292 (0.459)	0.163 (0.374)
	over 50	0.374 (0.486)	0.325 (0.474	0.313 (0.468)	0.488 (0.506)
Married		0.481 (0.502)	0.25 (0.439)	0.521 (0.505)	0.419 (0.499)
Children		1.122 (1.110)	1.15 (1.099)	1.167 (1.038)	1.047 (1.214)
Race	**Caucasian**	0.870 (0.498)	0.911 (0.158)	0.854 (0.144)	0.844 (0.213)
	African American	0.031 (0.436)	0.022 (0.267)	0.024 (0.202)	0.044 (0.213)
	Asian	0.069 (0.254)	0.067 (0.152)	0.049 (0.144)	0.044 (0)

[3] Means are shown and standard deviations are below in parenthesis.

	Hispanic	0.008 (0.150)	0 (0)	0.024 (0.213)	0 (0)
Smoke		0.008 (0.087)	0 (0)	0.021 (0.144)	0 (0)
Vegetarian or vegan		0.061 (0.240)	0.1 (0.303)	0.063 (0.245)	0.023 (0.152)
Alcohol		0.061 (0.240)	0.075 (0.267)	0.104 (0.309)	0 (0)
Income level	Less than $40,000	0.435 (0.498)	0.45 (0.503)	0.395 (0.494)	0.465 (0.505)
	$40,001-$80,000	0.252 (0.436)	0.25 (0.439)	0.271 (0.449)	0.233 (0.427)
	$80,001-$120,000	0.069 (0.254)	0.1 (0.304)	0.021 (0.144)	0.093 (0.294)
Education	Only high school	0.191 (0.394)	0.15 (0.362)	0.208 (0.410)	0.209 (0.412)
	Undergraduate degree	0.282 (0.452)	0.3 (0.494)	0.271 (0.449)	0.279 (0.454)
	Graduate degree	0.053 (0.226)	0.075 (0.267)	0.042 (0.202)	0.047 (0.213)
Change in caloric consumption from menu 1 to menu 2		-66.557 (272.222)	-5.275 (379.282)	-109.896 (192.952)	-75.186 (233.656)
Change in caloric consumption from menu 1 to menu 3		-22.947 (222.140)	6.05 (279.599)	-22.667 (192.787)	-50.233 (192.332)
Change in # of items ordered from menu 1 to menu 2		-0.038 (0.635)	0.341 (0.693)	-0.042 (0.504)	-0.167 (0.621)
Change in # of items ordered from menu 1 to menu 3		0.137 (0.699)	0.45 (0.714)	0.104 (0.627)	-0.116 (0.662)
# of subjects		131	40	48	43

Table 1 presents the means and standard deviations of the socio-economic and demographic characteristics, as well as the total caloric consumption of meals selected by participants across all treatment groups. Some of the socio-economic and demographic variables statistically significantly affected the intake of some of the nutritional factors. For example, participants with an income level of more than $160,000 consumed fewer calories from menu 1 to menu 2. It is also shown in Table 1 that while participants in the control group selected more items on menu 2 than on menu 1, participants in the two treatments selected fewer. The participants in the inclusive tax treatment purchased slightly more items on menu 3 than on menu 1, while participants in the exclusive tax treatment selected fewer. The mean change in calorie content for participants was negative across all groups, and the unhealthy food inclusive tax treatment had the biggest reduction of calorie consumption, and the added sweetened beverage inclusive tax treatment had the smallest reduction of calorie consumption. The mean change in calorie content for participants was negative across all groups, and the inclusive tax treatment had the biggest reduction in calorie consumption.

Table 2. Summary of change in food selection

i. From menu 1 to menu 2

Eating pattern	Δ unhealthy level[1]	Number of Subjects: Whole Menu				Number of Subjects: Beverage			
		C[2]	I	E	T	C	I	E	T
Less unhealthy[3]	<-2	5	7	4	16		2		2
	-2	8	7	3	18	1	3	1	5
	-1	8	6	5	19	5	4	1	10
Neutral[4]	0	8	24	26	58	31	29	40	100
Unhealthier[5]	1	3	2	3	8	2	9		11
	2	5	1	2	8	1	1	1	3
	>2	3	1		4				
% of change		80%	50%	40%	56%	22%	40%	7%	24%
- To less unhealthy		66%	83%	71%	73%	67%	47%	67%	55%
- To unhealthier		34%	17%	29%	27%	33%	53%	33%	45%
Total # of subjects		40	48	43	131	40	48	43	131

Eating pattern	Δ unhealthy level	Number of Subjects: Entrée				Number of Subjects: Snack			
		C	I	E	T	C	I	E	T
Less unhealthy[3]	<-2	2		1	3		1		1
	-2	8	1	4	13	3	3	2	8
	-1	4	10	3	17	11	7	8	26
Neutral[4]	0	12	36	33	81	19	31	27	77
Unhealthier[5]	1	7	1		8	6	6	6	18
	2	5		2	7	1			1
	>2	2			2				
% of change		70%	25%	23%	38%	52%	35%	37%	41%
- To less unhealthy		50%	92%	80%	66%	67%	65%	63%	65%
- To unhealthier		50%	8%	20%	34%	33%	35%	37%	35%
Total # of subjects		40	48	43	131	40	48	43	131

[1] Change in unhealthy level is calculated as follow: (# of unhealthy items in menu 2- # of healthy items in menu 2) - (# of unhealthy items in menu 1- # of healthy items in menu 1)

[2] C: Control group. E: Exclusive treatment. I: Inclusive treatment. T: Total.

[3] Less unhealthier: the difference between unhealthy and healthy items decreased from menu 1 to menu 2.

[4] Neutral: the difference between unhealthy and healthy items in menu 1 equals to that in menu 2.

[5] Unhealthier: the difference between unhealthy and healthy items increased from menu 1 to menu 2.

Table 2. (continued)

ii. From menu 1 to menu 3

Eating pattern	Δ unhealthy level[1]	Number of Subjects							
		Whole Menu				Beverage			
		C[2]	I	E	T	C	I	E	T
Less unhealthy[3]	<-2	5	3	2	10				
	-2	3	5	3	11		5	1	6
	-1	5	11	8	24	4	6	2	12
Neutral[4]	0	12	21	22	55	27	33	39	99
Unhealthier[5]	1	9	4	6	19	5	4	1	10
	2	5	4	2	11	4			4
	>2	1			1				
% of change		70%	44%	49%	42%	32%	31%	9%	24%
- To less unhealthy		46%	70%	62%	59%	31%	73%	75%	56%
- To unhealthier		54%	30%	38%	41%	69%	27%	25%	44%
Total # of subjects		40	48	43	131	40	48	43	131

Eating pattern	Δ unhealthy level	Number of Subjects							
		Entrée				Snack			
		C	I	E	T	C	I	E	T
Less unhealthy[3]	<-2	3	1		4		1		1
	-2	9	5	3	17	1	1	3	5
	-1	3	2	4	9	11	9	6	26
Neutral[4]	0	16	34	31	81	17	29	29	75
Unhealthier[5]	1	3	3	1	7	7	5	5	17
	2	6	2	4	12	4	3		7
	>2		1		1				
% of change		60%	29%	28%	38%	57%	40%	33%	43%
- To less unhealthy		63%	57%	58%	60%	52%	58%	64%	57%
- To unhealthier		37%	43%	42%	40%	48%	42%	36%	43%
Total # of subjects		40	48	43	131	40	48	43	131

[1] Change in unhealthy level is calculated as follow: (# of unhealthy items in menu 3- # of healthy items in menu 3) - (# of unhealthy items in menu 1- # of healthy items in menu 1)

[2] C: Control group. E: Exclusive treatment. I: Inclusive treatment. T: Total.

[3] Less unhealthier: the difference between unhealthy and healthy items decreased from menu 1 to menu 3.

[4] Neutral: the difference between unhealthy and healthy items in menu 1 equals to that in menu 3.

[5] Unhealthier: the difference between unhealthy and healthy items increased from menu 1 to menu 3.

The detailed numerical summary of the change in food selection is presented in Table 2. It is interesting to note that subjects in both menu 2 and menu 3, subjects in the inclusive tax and exclusive tax treatments actually made less change to their eating patterns than subjects in the control group. But in the two treatments, a bigger proportion of subjects who changed their eating pattern became less unhealthy compared to the control group. This was particularly evident in the entrée category comparing menu 1 with menu 2, where among subjects who changed their eating patterns, 92% became less unhealthy in the inclusive tax treatment, and 80% in the exclusive tax treatment. Meanwhile, if we look into the percentage of being less healthy, the numbers are very similar across treatments in the snack category. That is to say, although 41% of all subjects changed their eating patterns in the snack category, which was more than any other food categories, these changes were hardly caused by the treatments. The changes in eating pattern were more complicated when comparing menu 1 with menu 3. Because the tax was levied specifically on added sweetened beverage items, subjects showed the biggest desirable change in the beverage category, with 73% became less unhealthy in the inclusive treatment, and 75% in the exclusive tax treatment, compared to 31% in the control group. It is worth noting that 57% of the subjects in the inclusive tax treatment and 58% in the exclusive tax treatment, who changed their eating pattern, became less unhealthy in the entrée category, while the percentage in the control group was 63%. That is to say, the beverage tax treatments in fact caused fewer people to choose meals with less-unhealthy entrée.

Table 3 presents the results from the SUR estimation comparing each treatment with the control group based on the entire menu. While both inclusive tax and exclusive tax had negative impact on caloric consumption, only the inclusive tax was statistically significant. Subjects in this treatment consumed 156 fewer calories, which represented a 27.7% decrease from menu 1 to menu 2[4]. However, the added sweetened beverage taxes were less effective. Neither of the treatments with added sweetened beverage tax had significant negative impact on caloric consumption. The beverage inclusive tax treatment even had a positive effect on the change of calorie content.

As defined by the USDA, empty calories are "calories from food components such as added sugars and solid fats that provide little nutritional value". Empty calorie gives us a better understanding of people's intake of actual nutritional value. However, none of the treatment effects were significant. One similar nutrient is calories from fat; here only the unhealthy food inclusive tax treatment had significant negative impact of resulting in a 35.5% reduction.

[4] Unless otherwise specified, all estimated percentage changes cited in this paper are based on the comparison to second menu selection of the control group, or selections in corresponding food category of the second menu of the control group.

Table 3. Estimation result from the DID model; comparing each treatment with the control group based on the entire menu

Variable

	Calories	**Empty Calories**	**Calorie from fat**	**Carbohydrate**	**Fiber**
Unhealthy Food Inclusive tax treatment	**-155.893*** (57.846)**	-12.055 (21.203)	**-29.031* (17.972)**	**-20.822*** (6.365)**	-0.144 (0.524)
Unhealthy Food Exclusive tax treatment	-69.693 (60.430)	24.478 (22.150)	2.300 (18.775)	**-15.728** (6.649)**	**-1.078* (0.548)**
Added Sweetened Beverage Inclusive tax	12.130 (47.549)	-5.168 (20.734)	48.466 (15.945)	**-19.267*** (5.490)**	0.140 (0.492)
Added Sweetened Beverage Exclusive tax	-78.267 (49.641)	-30.693 (21.646)	31.220 (16.646)	**-25.266*** (5.731)**	**-1.222** (0.514)**

	Fat	**Cholesterol**	**Protein**	**Added Sugar**	**Sodium**
Unhealthy Food Inclusive tax treatment	-5.528 (3.654)	**-25.445** (11.292)**	**-6.447** (3.217)**	**-12.831*** (4.891)**	**-249.167* (147.853)**
Unhealthy Food Exclusive tax treatment	0.347 (3.818)	-1.573 (11.797)	-1.877 (3.361)	-6.047 (5.110)	66.687 (154.458)
Added Sweetened Beverage Inclusive tax	**6.880** (3.098)**	**25.025** (10.192)**	**6.459** (2.861)**	**-21.095*** (4.433)**	251.284 （128.115）
Added Sweetened Beverage Exclusive tax	1.785 (3.234)	**18.952* (10.641)**	2.034 (2.987)	**-16.594*** (4.628)**	214.7189 （133.752）
# of Observations	131				
Socio-economic dummies	gender, age, race, marital status, children, income level, educational level				
Other dummies	alcohol and smoking habits, vegan or vegetarian, self-assessed weight status, preferences over organic food				

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.

Some other nutritional factors such as carbohydrate, fat, cholesterol, added sugar and sodium are also considered undesirable nutrients, because they are generally over-consumed and thus are contributing to obesity and other health problems among the U.S population. Most of these nutritional factors changed significantly in the inclusive tax treatment except fat. For example, compared to the content of the second menu selection in the control group, subjects in the inclusive tax treatment consumed 13 less grams (49.2%) of added sugar and 25 less milligrams (42.4%) of cholesterol, a major determinant of cardiovascular disease and type II diabetes (ARS, 2010), from menu 1 to menu 2. While most of the significant changes occurred as expected, there were a few exceptions. The added sweetened beverage inclusive tax increased 6.88 more grams (28%) of fat content and the 25 more milligrams (36.9%) of cholesterol content compared to the control group. On the other hand, the exclusive taxes had no significant impact on the content of these undesirable nutrients except carbohydrates.

Nutrients such as fiber and protein are considered beneficial in diets (ARS, 2010). The only significant positive impacts on the beneficial nutrients were the increase of protein content in the added sweetened beverage inclusive tax treatment. As a matter of fact, the unhealthy food inclusive tax treatment even reduced 6 grams (25%) of protein compared to the control group, unhealthy food exclusive tax treatment reduced 1 gram of fiber, and the added sweetened beverage exclusive tax reduced 1 more gram of fiber, all of which were statistically significant. There have been researches indicating that low protein diets will cause overeating (Gosby et al. 2011), and an increased intake of dietary fiber would be useful for the treatment of obesity (Smith, 1987). Hence, one perverse result in both tax policies is reducing the content of such beneficial nutrients.

The separate estimation results from the DID model for the three main food categories are presented in Table 4. In the beverage category, calorie, carbohydrate and added sugar changed significantly in the unhealthy food inclusive tax treatment but not so in the unhealthy food exclusive tax treatment, which was consistent with the results in Table 3.

Calorie content was reduced by 28.8 kcal (60%) for beverages from menu 1 to menu 2 in the inclusive tax. What is worth noting is that the inclusive tax treatment also had a significant negative impact of 9 grams (32.9%) on empty calorie content this time, while the exclusive tax treatment still had no impact on it. That is to say, an unhealthy food inclusive tax treatment was more effective in reducing the intake of food with little nutritional value than was the unhealthy food exclusive tax. As for the added sweetened beverage tax, both the inclusive and exclusive tax treatment significantly reduced the calorie intake from menu 1 to menu 3 by 58 kcal and 56 kcal respectively, which is almost twice the amount reduced by unhealthy food inclusive tax. The contents of empty calories,

Table 4. Estimation result from the DID model; comparing each treatment with the control group for the main food categories

Beverage Only					
	Calories	**Empty Calories**	**Calorie from fat**	**Carbohydrate**	**Fiber**[5]
Unhealthy Food Inclusive tax treatment	**-28.771*** **(16.424)**	**-31.962*** **(16.626)**	0.818 (3.481)	**-7.827**** **(3.834)**	-
Unhealthy Food Exclusive tax treatment	-19.173 (17.158)	-17.144 (17.369)	-3.957 (3.636)	-3.314 (4.006)	-
Added Sweetened Beverage Inclusive tax	**-58.844***** **(15.160)**	**-61.800***** **(14.815)**	-1.666 (3.736)	**-14.949***** **(3.494)**	-
Added Sweetened Beverage Exclusive tax	**-56.302***** **(15.827)**	**-51.509***** **(15.467)**	-0.659 (3.895)	**-13.442***** **(3.648)**	-

	Fat	**Cholesterol**	**Protein**	**Added Sugar**	**Sodium**
Unhealthy Food Inclusive tax treatment	0.076 (0.374)	0.360 (1.031)	0.255 (0.728)	**-9.222**** **(3.874)**	-2.741 (9.914)
Unhealthy Food Exclusive tax treatment	-0.369 (0.390)	-1.196 (1.077)	-0.611 (0.761)	-0.677 (4.047)	-13.195 (10.357)
Added Sweetened Beverage Inclusive tax	-0.156 (0.348)	-0.268 (0.986)	0.231 （0.524）	**-17.797***** **（3.531）**	0.985 （9.564）
Added Sweetened Beverage Exclusive tax	-0.063 (0.364)	-0.519 （1.030）	-0.694 （0.547）	**-11.708***** **（3.686）**	**-26.884***** **（9.985）**

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

[5] Multicollinearity occurs when estimating the treatment effects on fiber, due to the low or zero fiber content of beverage items.

Table 4 (continued)

Entrée Only					
	Calories	**Empty Calories**	**Calorie from fat**	**Carbohydrate**	**Fiber**
Unhealthy Food Inclusive tax treatment	**-122.564*** **(77.166)**	-1.854 (18.629)	-22.484 (17.680)	-7.478 (5.464)	0.295 (0.389)
Unhealthy Food Exclusive tax treatment	9.822 (80.613)	16.611 (19.461)	7.662 (18.469)	-0.792 (5.708)	0.073 (0.407)
Added Sweetened Beverage Inclusive tax	**104.308**** **（49.815）**	**63.356***** **（17.085）**	**52.810***** **（15.618）**	2.719 （4.245）	0.513 （0.376）
Added Sweetened Beverage Exclusive tax	47.882 （52.007）	**31.685*** **（17.837）**	**36.033**** **（16.305）**	-0.087 （4.432）	-0.623 （0.393）

	Fat	**Cholesterol**	**Protein**	**Added Sugar**	**Sodium**
Unhealthy Food Inclusive tax treatment	-6.657 (4.833)	**-29.418**** **(14.598)**	**-7.280*** **(4.221)**	-1.757 (1.114)	-303.985 (200.749)
Unhealthy Food Exclusive tax treatment	1.468 (5.048)	2.884 (15.250)	0.506 (4.410)	0.256 (1.164)	137.658 (209.716)
Added Sweetened Beverage Inclusive tax	**7.721**** **（3.175）**	**26.491***** **（10.069）**	**6.640**** **（2.882）**	-0.516 （0.888）	**254.782**** **（128.427）**
Added Sweetened Beverage Exclusive tax	4.330 （3.315）	**22.691**** **（10.512）**	3.453 （3.009）	0.640 （0.927）	**275.821**** **（134.078）**

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 4 (continued)

Snack Only					
	Calories	**Empty Calories**	**Calorie from fat**	**Carbohydrate**	**Fiber**
Unhealthy Food Inclusive tax treatment	-4.610 (30.400)	4.784 (6.970)	1.627 (2.910)	1.138 (4.554)	-0.252 (0.390)
Unhealthy Food Exclusive tax treatment	-23.207 (31.768)	0.263 (7.281)	-0.300 (3.040)	-3.300 (4.757)	-0.584 (0.407)
Added Sweetened Beverage Inclusive tax	**-33.334*** **（19.710）**	**-6.723**** **（3.246）**	**-2.678*** **(1.439)**	**-7.037*** **（3.671）**	-0.373 (0.469)
Added Sweetened Beverage Exclusive tax	**-69.847***** **（20.578）**	**-10.869***** **（3.389）**	**-4.154***** **(1.502)**	**-11.737***** **（3.833）**	-0.599 (0.490)

	Fat	**Cholesterol**	**Protein**	**Added Sugar**	**Sodium**
Unhealthy Food Inclusive tax treatment	-0.648 (1.333)	2.765 (2.399)	-0.121 (0.388)	-1.100 (2.745)	-13.229 (24.740)
Unhealthy Food Exclusive tax treatment	-0.757 (1.392)	0.293 (2.506)	-0.245 (0.406)	-2.611 (2.868)	-17.400 (25.845)
Added Sweetened Beverage Inclusive tax	-0.686 (0.892)	-1.198 (1.430)	-0.412 (0.259)	-2.781 (2.441)	-4.483 (13.442)
Added Sweetened Beverage Exclusive tax	**-2.481***** **(0.931)**	**-3.219**** **(1.493)**	**-0.725***** **(0.270)**	**-5.526**** **(2.548)**	**-34.218**** **(14.034)**

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

carbohydrate and added sugar were also significantly reduced in both treatments by twice the amount reduced by unhealthy food inclusive tax. Sodium content decreased 26 milligrams in the exclusive tax treatment from menu 1 to menu 3.

When considering only the entrée category, calorie content significantly decreased by 122 kcal (25.3%) in the inclusive tax treatment from menu 1 to menu 2. Nutritional factors that changed significantly from menu 1 to menu 2 were cholesterol and protein in the inclusive tax treatment, with cholesterol content decreasing 29 milligrams (42.8%), and protein content decreasing by 7 grams (27.2%) compared to the control group. The direction of the estimated treatment effect on protein was still opposite the direction desired. The results of added sweetened beverage taxes, however, were quite surprising. Calories, empty calories and calorie from fat significantly increased by 104 kcal (21.3%), 63 kcal and 53 kcal respectively in the inclusive tax treatments from menu 1 to menu 3, and empty calories and calorie from fat also significantly increased in the exclusive tax treatment, by 32 kcal and 36 kcal respectively. Nutritional factors including fat, cholesterol and sodium also significantly increased from menu 1 to menu 3 in at least one of the treatment. Although the beverage inclusive tax increased 7 grams of protein content, the treatments still led to an unhealthier entrée selection in general.

If we consider the snack category only, none of the nutritional factors changed significantly in either of the unhealthy food tax treatment. The result is not surprising since it is consistent with our finding from Table 2. Added sweetened beverage taxes, however, had much more strong effect. Both the inclusive and exclusive tax treatment significantly decreased calorie, empty calorie, calorie from fat, carbohydrate intake. Other nutritional factors, except fiber, were also significantly reduced by added sweetened beverage exclusive tax.

Table 5. Estimation results from the DID model; comparing the inclusive tax treatment with exclusive tax treatment based on the entire menu

Variable	Calories	Empty Calories	Calorie from fat	Carbohydrate	Fiber
Unhealthy Food	-50.329	**-51.611****	-30.187	3.931	-0.145
Inclusive tax treatment	(47.579)	**(21.820)**	(18.935)	(6.409)	(0.486)
Added Sweetened	69.226	32.571	12.002	4.741	**1.188****
Beverage Inclusive tax	(46.189)	(20.903)	(14.876)	(6.054)	**(0.547)**

	Fat	Cholesterol	Protein	Added Sugar	Sodium
Unhealthy Food	**-5.680****	**-21.534****	-3.275	-4.781	-137.584
Inclusive tax treatment	**(2.830)**	**(9.686)**	(2.730)	(4.842)	(122.615)
Added Sweetened Bevera	3.836	3.430	3.676	-4.802	19.517
Inclusive tax	(2.620)	(8.777)	(2.500)	(4.609)	(124.099)
# of Observations	91				
Socio-economic dummies	gender, age, race, marital status, children, income level, educational level				
Other dummies	alcohol and smoking habits, vegan or vegetarian, self-assessed weight status, preferences over organic food				

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0

Table 5 presents the estimation results considering the entire menu, and used the DID model that compares the two treatments with each other. Table 5 helps us to determine if the impacts in the inclusive tax treatment and in the exclusive tax treatment are significantly different. The change in calorie content was not significantly different between the two treatments both from menu 1 to menu 2 and to menu 3. However, this time empty calorie intake in the unhealthy food inclusive tax treatment changed significantly, compared to the unhealthy food exclusive tax treatment, with 52 fewer empty calories (49.9%)[6] consumed in the inclusive tax treatment than in the exclusive tax treatment. Fat and cholesterol content also changed significantly in the unhealthy food inclusive tax treatment, with fat content reduced 6 grams (26.2%) and cholesterol content reduced 22 milligrams (36%). Researchers have concluded that a reduction in fat intake reduces the gap between total energy intake and total energy expenditure and thus would help reduce obesity (Bray and Popkin, 1998). Others have shown that the greater body weight the higher was the rate of cholesterol synthesis (Miettinen, 1971). Hence, the significant reduction in empty calorie, fat and cholesterol reinforces our conclusion that an inclusive tax had a substantially stronger impact than an exclusive tax on reducing the content of undesirable nutritional factors. The difference between added sweetened beverage inclusive and exclusive tax was less significant. Only the fiber content changed significantly by 1.2 grams from menu 1 to menu 3.

[6] Percentage changed here is estimated by the comparison to the second menu selection of the exclusive tax treatment.

ii) Ordered Probit Model

By taxing an item or not, we divided the food items into groups of healthy and unhealthy. Hence, we were able to count the number of unhealthy items selected in each menu. To investigate how the choices of consumers were changed by different treatments, we constructed the ordered probit model as follows.

$$Y_i^* = \alpha + \theta X_i + \sum_{d=1}^{2} \beta_d D_d + \varepsilon_i, \tag{8}$$

where

$$Y_i^* = \begin{cases} 0, & \Delta C_i < 0 \\ 1, & \Delta C_i = 0 \\ 2, & \Delta C_i > 0 \end{cases}$$

ΔC_i is the change in the number of unhealthy items chosen from menu 1 to menu 2 (or menu 3). Therefore Y_i^* equals 0, 1, and 2, indicating the change of individual i being "less unhealthy", "unchanged" and "unhealthier", or in other words, purchasing less, the same or more unhealthy items respectively, in comparison to their selection in menu 1.

Table 6: Excise and sale tax effects with the ordered probit model (marginal effect).

	Whole Menu		
	P(Y*=0)	P(Y*=1)	P(Y*=2)
Unhealthy food excise tax	**0.115***	-0.021	**-0.095***
	(0.085)	(0.034)	**(0.044)**
Unhealthy food sale tax	0.046	-0.022	-0.025
	(0.089)	(0.043)	(0.046)
Added sweetened beverage excise tax	**0.141***	-0.036	**-0.105***
	(0.079)	(0.036)	**(0.052)**
Added sweetened beverage sales tax	0.098	-0.024	-0.078
	(0.071)	(0.024)	(0.053)

P(Y*=0) is the probability of being "less unhealthy" after the treatment.

P(Y*=1) is the probability of having a "unchanged" eating pattern before and after the treatment.

P(Y*=2) is the probability of being "unhealthier" after the treatment.

Values in parenthesis are the standard errors and the ***, **, and * are 99%, 95%, and 90% confidence intervals respectively.

Results

Table 6 presents the marginal effects of different treatments obtained from ordered probit model. The unhealthy food inclusive tax caused a 12.5% higher probability of subjects being less unhealthy, and 9.5% lower probability of subjects being unhealthier. On the other hand, the added sweetened beverage inclusive tax led to a 14.1% higher probability of subjects being less unhealthy, and 10.5% lower probability of subjects being unhealthier, compared to the control group. All of these impacts were statistically significant. Neither of the exclusive tax showed significant impact on any of the changes.

Table 7: Food advertisement effects with the ordered probit model for each food category (marginal effect)

	Beverage		
	P(Y*=0)	P(Y*=1)	P(Y*=2)
Unhealthy food excise tax	0.006	-0.0002	-0.005
	(0.034)	(0.024)	(0.032)
Unhealthy food sales tax	-0.004	0.000	0.004
	(0.037)	(0.002)	(0.038)
Added sweetened beverage excise tax	**0.11*** **	-0.042	**-0.123***
	(0.046)	(0.034)	**(0.074)**
Added sweetened beverage sales tax	0.022	0.012	-0.035
	(0.055)	(0.031)	(0.086)
	Entrée		
	P(Y*=0)	P(Y*=1)	P(Y*=2)
Unhealthy food excise tax	**0.161****	-0.028	**-0.132****
	(0.080)	(0.041)	**(0.041)**
Unhealthy food sales tax	0.003	-0.001	-0.002
	(0.081)	(0.036)	(0.045)
Added sweetened beverage excise tax	-0.090	-0.026	**0. 116***
	(0.058)	(0.020)	**(0.064)**
Added sweetened beverage sales tax	-0.054	-0.019	0.074
	(0.055)	(0.018)	(0.068)
	Snacks		
	P(Y*=0)	P(Y*=1)	P(Y*=2)
Unhealthy food excise tax	0.050	-0.030	-0.021
	(0.060)	(0.039)	(0.023)
Unhealthy food sales tax	0.100	-0.065	-0.035
	(0.069)	(0.052)	(0.023)
Added sweetened beverage excise tax	0.038	0.011	-0.049
	(0.054)	(0.014)	(0.066)
Added sweetened beverage sales tax	0.062	0.014	-0.076
	(0.060)	(0.014)	(0.066)

P(Y*=0) is the probability of being “less unhealthy” after the treatment .

P(Y*=1) is the probability of having a “unchanged” eating pattern before and after the treatment.

P(Y*=2) is the probability of being “unhealthier” after the treatment.

Values in parenthesis are the standard errors and the ***, **, and * are 99%, 95%, and 90% confidence intervals respectively.

Table 7 presents the marginal effects with respect to different food categories. The results were consistent with the results obtained from the DID model. Unhealthy food inclusive tax had significant impact on the change in the purchase of entree items, with 16.1% higher probability of subject being less unhealthy, and 13.2% lower probability of being unhealthier. On the other hand, participants in added sweetened beverage inclusive tax treatment had 11% higher probability of purchasing fewer unhealthy beverages, and 12.3% lower probability of purchasing more unhealthy beverages, compared to the control group. What is worth noting is that like the results we had in table 4, this treatment also caused 11.6% higher probability of subjects purchasing more unhealthy-entrée items. The exclusive tax treatment again had no significant impact in any category.

iii) Discussion

We examined the impact of two types of taxes: an unhealthy food excise (inclusive) tax and a sales (exclusive) tax. Generally speaking, the inclusive tax had a stronger impact on the nutritional content of the meal: the inclusive tax, which the subjects experienced as a 20% excise tax levied on unhealthy food items or added sweetened beverage items, led to the reduction of some undesirable nutritional factors such as calories, calories from fat, carbohydrates, fat, cholesterol, added sugar and sodium. On the other hand, the exclusive tax, which the subjects experienced as a 20% sales tax levied on unhealthy food items or added sweetened beverage items, only led to a significant reduction of carbohydrates, cholesterol and added sugar. The reason for this can be explained by the theoretical model: people lack the knowledge of tax status, and they tend to under-react to a tax that was not reflected in the shelf price. Firstly, because the items that were taxed were not specified on the menu, people in the exclusive tax treatment were less clear about the exact tax status of each item than people in the inclusive tax treatment, although the name of the tax (i.e., "unhealthy food tax") was presented. Secondly, even for items of which people were certain about the tax status, they tended to underestimate the after-tax price due to the complexity of calculating the amount of the tax.

While all treatments had a negative impact on at least some undesirable nutritional factors, there were also perverse results, specifically, both unhealthy food tax treatments had negative impacts on the contents of beneficial nutrients such as protein and fiber, and some of these impacts were statistically significant. This represents an unintended consequence of such health policies. One possible explanation is that for some subjects, the tax treatments nudged them into eating less, so instead of switching from an unhealthy item to a healthy one, they actually purchased fewer items in response to the tax. And according to Table 1, the more they were uncertain about the tax, the fewer items they would purchase. Therefore, the consumption of beneficial nutrients such as fiber and protein decreased as the number of items ordered decreased.

If we investigate the impacts by food categories, the impact of the unhealthy food inclusive tax was stronger than the exclusive tax in beverage and entrée category. The inclusive tax treatment had the strongest impact on beverage items, with more nutrients affected in this category than in any of the others, while the nutritional composition of the snack category was barely affected by either of the treatments. In addition, although both treatments positively affected the fiber content in the entrée category, neither of these effects was significant – the effect of the taxes on beneficial nutrients was still perverse in all food categories.

However, the results with respect to the added sweetened beverage tax vary across categories. Although the calorie content decreased significantly in both treatments in the beverage category, the decrease of caloric intake was offset by the increase of it in the entrée category. That is to say, the positive effect of added sweetened beverage tax on beverage items was canceled out by an unhealthier selection of entrée items, and this was more evident in the inclusive tax treatment than in the exclusive tax treatment. What's more, unlike the results considering the whole menu, the added sweetened beverage exclusive tax had a stronger effect on snack items than an inclusive tax.

By comparing the change of in selected nutritional factors in the inclusive tax treatment with that in the exclusive tax treatment, we examined if the impacts of these two policies were significantly different. While the unhealthy food inclusive tax had a negative impact on most of the undesirable nutritional factors compared to the exclusive tax, the nutrients that changed significantly between the treatments were quite different from those between the treatments and the control group. The DID model comparing the two treatments yielded different results for factors such as empty calories and fat. The unhealthy food inclusive tax treatment had a significantly stronger impact in reducing empty calories, fat and cholesterol than the exclusive tax treatment. However, the change in calories was not significantly different between the treatments. A tax-inclusive price being more informative could be one possible reason. As people were more familiar with calories than with most of the specific nutrients, subjects would avoid high-calorie items in both treatments, so the change in calorie content was not significantly different. Since the inclusive tax better informed people which item was indeed unhealthy, it helped in reducing the content of empty calories, cholesterol and other undesirable nutrients that people were less familiar with.

The difference between effects of added sweetened beverage taxes was much less significant, with only fiber content increased significantly in the inclusive tax treatment.

The results we obtained from the probit models showed that in general, the unhealthy food inclusive tax treatment had a stronger impact on the subjects' selection than the unhealthy food exclusive tax treatment. Meanwhile, the impact of added sweetened beverage inclusive tax here was consistent with that from the DID model. Subjects significantly purchase less unhealthy items in the beverage entrée, but more unhealthy items in the entrée category from menu 1 to menu 3 in the inclusive tax treatment.

VI. Conclusions

This research focused on the impact of two types of taxes on consumers' purchasing behavior. In order to identify the more effective policy for reducing obesity, we empirically examined the impact of an inclusive tax and an exclusive tax on consumption patterns by conducting through the use of a laboratory experiment.

Based on our estimation results, both the inclusive and exclusive unhealthy food tax had negative impacts on the consumption of undesirable nutritional factors such as cholesterol and added sugar, but the inclusive tax was much more effective than the exclusive tax. This effect was robust to the entire menu, the beverage category and the entrée category for the unhealthy food taxes, and to the entire menu and the beverage category for the added sweetened beverage taxes. By comparing the change in nutrient content for the two treatments, the results indicated that the effect of the unhealthy food inclusive tax was significantly stronger than exclusive tax. However, both treatments had the unintended consequence of also reducing the consumption of some beneficial nutrients including fiber and protein, which might compromise the dietary balance.

To obtain a better understanding of how the policies changed the nutritional composition by food categories, we found that in the inclusive tax treatment, compared to the other two categories, the nutritional composition of selected beverages changed more significantly for both the unhealthy food tax and added sweetened beverage tax. But what is worth noting is that the effects of added sweetened beverage taxes on beverage items were counterbalanced or even overweighed by the unhealthier selection in the entrée category. Therefore the effect of such beverage taxes was ambiguous in general.

Our study contributes to the existing literature by providing empirical evidence to support theoretical models of how tax salience affects healthy eating. One major result of our study is that an unhealthy food inclusive tax policy has a significantly and substantially stronger effect than an unhealthy food exclusive tax. This finding provides an important policy implication for framing the unhealthy food tax policy to reduce obesity. That is, an excise tax works not only in encouraging people to eat healthier, but more importantly guiding people to eat a less unhealthy meal that includes undesirable nutritional factors. Another result is that while significantly reduce the caloric consumption from beverages, an added sweetened beverage tax might lead to an unhealthier diet in food categories other than beverage at the same time. Therefore, it is more effective if the scope of a fat tax is expanded to include all calorie-dense food.

One important caveat of this study is its laboratory setting, which may not correspond to choices observed in the real world. First, in the experiment the rate of unhealthy food tax was presented to the subjects both orally and in written form, while in reality, people are less clear about the exact tax rate. Second, in a laboratory setting, participants are aware that their decision will be thoroughly investigated, which is not true in the real world. Third, the effect is unlikely to persist over time. Thus our results should be viewed as an upper bound for the actual effect of various tax policies and serve as an indication of the relative effects of the proposed measures (Levitt and List, 2007). Another caveat we have to acknowledge the experiment design of menu 3. For one thing, because subjects were presented with the total price of their selections on menu 2 before they started selecting on menu 3, their perception of the amount of tax would be affected, hence their purchasing decision on menu 3 would also be affected. For another, subjects in the treatments experienced the unhealthy food tax in menu 2, so for them, the prices of unhealthy beverage and entrée items actually decreased from menu 2 to menu 3, and such a decrease in price would inevitably affect their selection on menu 3. But as we always had the unhealthy food taxes presented to them in menu 2, the flaws in the design of menu 3 only contaminated the results of added sweetened beverage taxes, but leave the results of unhealthy food taxes to be unaffected. Consequently, the results generated from our laboratory experiment should be generalized with caution.

Despite the effects of limitations, the caloric intake and nutrient intake of this lab study provide the first comparison of excise taxes and sales taxes. Further research is needed to study the long-term effects and examine the change in nutritional quality across all meals in a day. Overall, to our knowledge, this is the first study that involves empirical evidence to suggest a well-designed unhealthy food excise tax policy might be more effective than an unhealthy food sales tax policy in reducing obesity.

APPENDICES

A1. Items and respective prices in control and treatments

Items	Price (1)	Price (2)	Price (3)
Diet Pepsi (20 oz.)	$1.85	$1.85	$1.85
Pepsi (20 oz.)	$1.85	$2.22	$2.22
Gatorade Low Calorie	$2.15	$2.15	$2.15
Mountain Dew (20 oz.)	$1.85	$2.22	$2.22
Unsweetened Iced Tea LIPTON	$2.15	$2.15	$2.15
Original Iced Tea LIPTON	$2.15	$2.58	$2.58
Tropicana Lemonade	$1.85	$2.22	$2.22
Propel Zero	$2.25	$2.25	$2.25
Grabba Whole Milk	$1.49	$1.79	$1.79
Grabba Fat Free Milk	$1.49	$1.49	$1.49
Ocean Spray Juice Drink	$2.15	$2.58	$2.58
Bottled Water	$1.95	$1.95	$1.95
Green Salad (Sesame or Balsamic Dressing)	$7.49	$7.49	$7.49
Green Salad with Tuna (Sesame or Balsamic Dressing)	$7.49	$7.49	$7.49
3 Chicken Fingers	$5.69	$6.83	$5.69
Cheese Pizza (personal pan 6")	$4.25	$5.10	$4.25
Pepperoni Pizza (personal pan 6")	$4.75	$5.70	$4.75
Bacon Cheeseburger	$6.27	$7.07	$6.27
Turkey Burger	$4.49	$4.49	$4.49
Garden Burger	$4.49	$4.49	$4.49
French Fries	$1.99	$2.39	$1.99
Tuna Salad Sandwich	$4.99	$4.99	$4.99
Chicken or Steak Fajita Quesadilla	$6.79	$8.15	$6.79
Lo-Mien Noodle Bowl with Chicken	$4.99	$4.99	$4.99
Veggie Cup	$2.99	$2.99	$2.99
Seaweed Salad	$4.99	$4.99	$4.99
Tempura Vegetable Roll	$6.49	$6.49	$6.49
SunChips (small bag)	$1.09	$1.31	$1.09
Fresh Apple	$1.00	$1.00	$1.00
Fresh Banana	$1.00	$1.00	$1.00
Fresh Orange	$1.00	$1.00	$1.00
5 Pack Cookies	$1.89	$2.27	$1.89
Brownie	$1.59	$1.99	$1.59

1) Posted and total price for items on menu 1, menu 2 and menu 3 of control, and menu 1 of exclusive tax treatment and inclusive tax treatment. Posted price for items on menu 2 and menu 3 of exclusive tax treatment
2) Posted and total price for items on menu 2 of inclusive tax treatment. Total price for items on menu 2 of exclusive tax treatment.
3) Posted and total price for items on menu 3 of inclusive tax treatment. Total price for items on menu 3of exclusive tax treatment.

A2. Socio-demographic questions and answer option list

#	Question	Answer Options/Description
1	What is your gender?	Drop-down list: - male - female
2	What is your age?	Drop-down list: - 20 or less - 21-30 - 31-40 - 41-50 - 51 or more
3	What is the highest level of education you have achieved?	Drop-down list: - High School - Undergraduate degree - Associate degree - Graduate degree or higher
4	How would you describe yourself?	Drop-down list: - Caucasian - African American - Asian/Asian American - Hispanic - Native American - Other
5	What is your family household income level?	Drop-down list: - Less than $40,000 - $40,001-$80,000 - $80,001-$120,000 - $120,001-$160,000 - Over 160,000 - Decline to answer
6	What is your marital status?	Drop-down list: - single - married - divorce
7	How many children do you have?	Drop-down list: - no - one - two - three - four - more than four
8	Do you smoke?	Drop-down list: - yes - no
9	Are you a vegetarian or a vegan?	Drop-down list: - yes - no
10	Do you drink alcoholic beverages?	Drop-down list: - yes - no
11	How would you describe your health condition?	Drop-down list: - underweight - normal weight - slightly overweight - overweight - obese
12	Do you often buy organic products?	Drop-down list: - yes - no

A3. Consent Form

Lunch Food Experiment

You are invited to take part in a research study that analyzes food purchase decisions. Please read this form carefully, and ask any questions you may have before agreeing to take part in the study.

What the study is about: The purpose of this study is to understand how some factors affect consumer's food purchase decisions for lunch items.

What we will ask you to do: We will ask you to select lunch items from a number of menus. For each menu, we will give you $10 to use to purchase the food items. At the end of the experiment, we will randomly select one of the menus that you completed. At the end we will also ask you to complete a questionnaire, which will elicit demographic information regarding yourself.

Risks and benefits: We do not anticipate any risks to you participating in this study other than those encountered in day-to-day life.

Compensation: You will receive a monetary compensation of $10 in food items and $20 cash if you go under $10 endowment. If you go over $10 endowment, the excess will be taken from your $20 cash payment.

Your answers will be confidential: The records of this study will be kept private. In any sort of report we make public we will not include any information that will make it possible to identify you. Research records will be kept in a locked file; only the researchers will have access to the records.

Taking part is voluntary: Taking part in this study is completely voluntary. You are free at all times to stop with the experiment, but you must complete the experiment to receive the compensation.

If you have any questions: The researcher conducting this study is Professor Harry Kaiser. Please ask any questions you have now. If you have any questions or concerns regarding your rights as a subject in this study, you may contact the Institutional Review Board (IRB) at 607.255.5138 or access their website at http://www.irb.cornell.edu. You may also report your concerns or complaints anonymously through Ethicspoint or by calling toll free at 866.293.3077. Ethicspoint is an independent organization that serves as a liaison between the University and the person bringing the complaint so that anonymity can be ensured.

Statement of Consent: I have read the above information, and have received answers to any questions I asked. I consent to take part in the study.

Your Signature __________Date ______________________

Your Name (printed) _______________Signature of person obtaining consent __________ Date _______

Printed name of person obtaining consent _________________ Date ___________________

A4. Instruction of the laboratory experiment

Instructions of a Lunch Food Experiment

You are going to participate in an experiment today that will last less than one hour. Please read these instructions carefully and refrain from communicating with other participants. As stated in the Consent Form, your participation in this experiment is voluntary and you can withdraw from this experiment at any time.

Completing Your Menu

You will be endowed with $10 to purchase food for your lunch from each menu we provide. One of the menus will be chosen by a random draw, and you will purchase the food items from the menu that is drawn at the end of the experiment.

This experiment will consist of four parts. You will be asked to choose the foods from a series of menus with your endowment. Note that for each menu, you are allowed to purchase foods over the $10 budget; however, if you go over your $10 endowment, **the excess will be taken from your $20 payment.** If you go under the $10 endowment, **you will not receive the difference in cash.**

For example, if your total expense on food in one menu is $12, you can decide whether to drop some food items to keep your balance within the budget, or pay extra $2 from the $20 payment at the end of the experiment if that menu is randomly drawn.

You will be asked to do a short survey right after you finish selecting foods from the last menu, with a series of socioeconomic questions. Then ***one of the menus will be randomly drawn and you will purchase the food items you selected on the drawn menu.*** Depending on whether you go over the budget of $10 or not, you might have to pay anything over $10 in cash from your $20 payment.

In addition to the $10 endowment, which may only be used for buying lunch food items from our menus, each experiment participant will be given $20 cash solely for participation.

*** Please keep in mind that you can choose as many Lunch Food items from the menu as you want. However, we provide you with a $10 budget. If you spend over $10 in Lunch Food items, you will have to* ***pay the extra in cash from the $20 cash payment****. If, on the other hand, your Lunch Food items together cost* ***less than $10, you will not be reimbursed*** *the difference. ***

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